
MATTHEW J. ZAHR

Luis W. Alvarez Postdoctoral Fellow
Department of Mathematics
University of California, Berkeley
Lawrence Berkeley National Laboratory

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RESEARCH INTERESTS

model order reduction · finite element methods · topology optimization · high-order methods · PDE-constrained optimization · multiphysics simulations · numerical linear algebra · numerical optimization · uncertainty quantification · multiscale methods

ACADEMIC POSITIONS

- 2016–2018 **Luis W. Alvarez Postdoctoral Fellow**, Department of Mathematics, University of California, Berkeley
2016–2018 **Postdoctoral Scholar**, Department of Mathematics, University of California, Berkeley
2015–2016 **Research Assistant**, Department of Aeronautics and Astronautics, Stanford University

EDUCATION

- Sep 2016 **Ph.D., Computational and Mathematical Engineering, Stanford University** *Stanford, CA*
Advisor: Charbel Farhat; GPA: 4.0
Ph.D. Minors: Mechanical Engineering, Aeronautics and Astronautics
Funding: Department of Energy Computational Science Graduate Fellowship
Dissertation: “Adaptive model reduction to accelerate optimization problems governed by partial differential equations”
- May 2016 **M.S., Computational and Mathematical Engineering, Stanford University** *Stanford, CA*
Advisor: Charbel Farhat; GPA: 4.08
- May 2011 **B.S., Civil and Environmental Engineering, University of California, Berkeley** *Berkeley, CA*
Minor: Mathematics; Advisor: Sanjay Govindjee; GPA: 3.997

OVERVIEW

15 papers: 6 journal, 8 conference, 1 book chapter
Luis W. Alvarez Postdoctoral Fellowship recipient (2016–2018)
Robert J. Melosh Medall Finalist: best student paper in finite element analysis (2015)
Department of Energy Computational Science Graduate Fellowship recipient (2011–2015)
Designed, taught advanced MATLAB programming course (CME292) at Stanford University while a graduate student
1 education grant: \$40k from MathWorks to convert CME292 into Massive Open Online Course (MOOC)
University Medal Finalist, UC Berkeley: ranked in top 5 of graduation class (2011)
Civil Engineering Department Citation, UC Berkeley: ranked 1st in CE department (2011)

HONORS & AWARDS

- 2016–2018 **Luis W. Alvarez Postdoctoral Fellowship**, Lawrence Berkeley National Laboratory *Berkeley, CA*
2 year, independent research fellowship
- Jun 2015 **MathWorks grant (\$40k) to convert CME292 (Stanford University) into MOOC**
- Apr 2015 **Robert J. Melosh Medal Finalist**, Duke University *Durham, NC*
Best student paper in finite element analysis
- May 2011 **University Medal Finalist**, University of California, Berkeley *Berkeley, CA*
Campus-wide award to most distinguished graduating senior
- Feb 2017 **Early Career Travel Award**
SIAM Conference on Computational Science and Engineering (February 2017)

- 2013–2016 **Student Travel Award**
 International Meshing Roundtable (September 2016)
 SIAM Conference on Uncertainty Quantification (April 2016)
 World Congress on Computational Mechanics XI (July 2014)
 International Conference on Spectral and Higher-Order Methods (June 2014)
 SIAM Conference on Optimization (May 2014)
 San Diego Supercomputing Summer Institute, HPC Workshop (August 2013)
- May 2011 **Civil Engineering Department Citation**, University of California, Berkeley *Berkeley, CA*
 Department-wide award to most distinguished student
- Aug 2010 **Best Project Award, 2010 AHPCRC Summer Institute Presentation**, Stanford University *Stanford, CA*
- Apr 2010 **Structural Engineers Association of N. California (SEAONC) Scholarship**
- May 2009 **Louise Cooper Endowment**, University of California, Berkeley *Berkeley, CA*
 Ranked 1st in CEE department
- Aug 2009 **Best Overall Project, 2009 Young Researchers Symposium**

PUBLICATIONS

THESIS

- [1] M. J. Zahr, *Adaptive model reduction to accelerate optimization problems governed by partial differential equations*. PhD thesis, Stanford University, August 2016

BOOK CHAPTER

- [2] M. J. Zahr and P.-O. Persson, “Energetically optimal flapping wing motions via adjoint-based optimization and high-order discretizations,” in *Frontiers in PDE-Constrained Optimization*, Springer, 2017

JOURNAL

- [3] M. J. Zahr, P. Avery, and C. Farhat, “A multilevel projection-based model order reduction framework for nonlinear dynamic multiscale problems in structural and solid mechanics,” *International Journal for Numerical Methods in Engineering*, In review 2016
- [4] M. J. Zahr, K. Carlberg, and D. P. Kouri, “Adaptive stochastic collocation for PDE-constrained optimization under uncertainty using sparse grids and model reduction,” *SIAM Journal on Uncertainty Quantification*, In preparation 2016
- [5] M. J. Zahr, P.-O. Persson, and J. Wilkening, “A fully discrete adjoint method for optimization of flow problems on deforming domains with time-periodicity constraints,” *Computers & Fluids*, 2016
- [6] M. J. Zahr and P.-O. Persson, “An adjoint method for a high-order discretization of deforming domain conservation laws for optimization of flow problems,” *Journal of Computational Physics*, 2016
- [7] M. J. Zahr and C. Farhat, “Progressive construction of a parametric reduced-order model for PDE-constrained optimization,” *International Journal for Numerical Methods in Engineering*, vol. 102, no. 5, pp. 1111–1135, 2015
- [8] D. Amsallem, M. J. Zahr, and K. Washabaugh, “Fast local reduced basis updates for the efficient reduction of nonlinear systems with hyper-reduction,” *Advances in Computational Mathematics*, pp. 1–44, 2015
- [9] D. Amsallem, M. J. Zahr, Y. Choi, and C. Farhat, “Design optimization using hyper-reduced-order models,” *Structural and Multidisciplinary Optimization*, pp. 1–22, 2014
- [10] D. Amsallem, M. J. Zahr, and C. Farhat, “Nonlinear model order reduction based on local reduced-order bases,” *International Journal for Numerical Methods in Engineering*, vol. 92, no. 10, pp. 891–916, 2012

CONFERENCE

- [11] M. J. Zahr and P.-O. Persson, “High-order, time-dependent aerodynamic optimization using a discontinuous Galerkin discretization of the Navier-Stokes equations,” in *AIAA Science and Technology Forum and Exposition (SciTech 2016)*, (San Diego, California), 1/4/16 – 1/8/2016
- [12] D. De Santis, M. J. Zahr, and C. Farhat, “Gradient-based aerodynamic shape optimization using the FIVER embedded boundary method,” in *AIAA Science and Technology Forum and Exposition (SciTech 2016)*, (San Diego, California), 1/4/16 – 1/8/2016
- [13] M. J. Zahr and P.-O. Persson, “Performance tuning of Newton-GMRES methods for discontinuous Galerkin discretizations of the Navier-Stokes equations,” in *Proc. of the 21st AIAA Computational Fluid Dynamics Conference*, vol. AIAA-2013-2685, American Institute of Aeronautics and Astronautics, 6/24/2013 – 6/27/2013
- [14] M. J. Zahr, D. Amsallem, and C. Farhat, “Construction of parametrically-robust CFD-based reduced-order models for PDE-constrained optimization,” in *Proc. of the 21st AIAA Computational Fluid Dynamics Conference*, vol. AIAA-2013-2685, American Institute of Aeronautics and Astronautics, 6/24/2013 – 6/27/2013

- [15] K. Washabaugh, D. Amsallem, M. J. Zahr, and C. Farhat, “Nonlinear model reduction for CFD problems using local reduced-order bases,” in *42nd AIAA Fluid Dynamics Conference and Exhibit, Fluid Dynamics and Co-located Conferences*, vol. 2686, 6/25/2012 – 6/28/2012
- [16] K. Washabaugh, M. J. Zahr, and C. Farhat, “On the use of discrete nonlinear reduced-order models for the prediction of steady-state flows past parametrically deformed complex geometries,” in *AIAA Science and Technology Forum and Exposition (SciTech 2016)*, (San Diego, California), 1/4/16 – 1/8/2016

TECHNICAL REPORTS

- [17] M. J. Zahr and S. Govindjee, “Theoretical and numerical foundations for the use of microcolumns as angular motion sensors,” tech. rep., University of California, Berkeley, 2011
- [18] M. J. Zahr, K. Carlberg, D. Amsallem, and C. Farhat, “Comparison of model reduction techniques on high-fidelity linear and nonlinear electrical, mechanical, and biological systems,” tech. rep., University of California, Berkeley, 2010
- [19] M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile reinforced concrete buildings using seismic risk maps,” tech. rep., United States Geologic Survey (USGS), 2009

TEACHING EXPERIENCE & RESEARCH MENTORING

CURRICULUM DEVELOPMENT AND INSTRUCTION

- Spr 2014 **Advanced MATLAB for Scientific Computing (CME 292)**, Stanford University
- Aut 2014 Intended to teach graduates students advanced MATLAB topics useful in research; Applications drawn from scientific computing: linear algebra and optimization, ODEs/PDEs, etc; *Award*: Received \$40k grant from MathWorks to convert courses into MOOC
- Spr 2015
- Smr 2013 **Classical Solutions to Partial Differential Equations (CME 001)**, Stanford University
Refresher course intended to prepare first year ICME for upcoming coursework and qualifying exams

RESEARCH MENTORING

- Spr 2016 **Gabriele Boncoraglio**, *M.S., Aeronautics and Astronautics, Stanford University*
Project: Accelerating PDE-Constrained Optimization with Partially Converged Solutions and Model Reduction
- Aut 2015 **Christina White**, *M.S., Mechanical Engineering, Stanford University*
Project: Machine Learning Algorithms in Model Order Reduction
- Smr 2015 **Fredrick Earnest**, *B.S., Mechanical and Aerospace Engineering, New Mexico State University*
Undergraduate Research Intern, Army High Performance Computing Research Center, Stanford University
Project: Projection-based model order reduction for nonlinearly constrained contact
- Smr 2014 **Joseph Graff**, *B.S., Mechanical and Aerospace Engineering, New Mexico State University*
Undergraduate Research Intern, Army High Performance Computing Research Center, Stanford University
Project: Automated mesh generation and validation for CFD analysis and shape optimization
- Smr 2014 **Zach Nevills**, *B.S., Mechanical Engineering, Stanford University*
Undergraduate Research Intern, Army High Performance Computing Research Center, Stanford University
Project: Automated mesh generation and validation for CFD analysis and shape optimization
- Smr 2014 **Harry Pham**, *B.S., Mechanical Engineering, Stanford University*
Undergraduate Research Intern, Army High Performance Computing Research Center, Stanford University
Project: Implementation of an aeroelastic shape optimization driver
2nd Place, Best Project Award

ACADEMIC SERVICE

JOURNAL REFEREE

American Institute of Astronautics and Aeronautics (AIAA) Journal · Computer Methods in Applied Mechanics and Engineering (CMAME) · International Journal for Numerical Methods in Engineering (IJNME) · Journal of Computational Physics (JCP) · Journal of Computational Science (JCS) · Journal of Computational and Applied Mathematics (JCAM)

CONFERENCE SESSION CHAIR

- M.J. Zahr, “MS: Applications of Computational Fluid Dynamics,” 43rd AIAA Fluid Dynamics Conference and Exhibit, San Diego, CA, June 24–27, 2013
- M.J. Zahr, “MS: Applications of Optimization,” SIAM Conference on Optimization, San Diego, CA, May 19–22, 2014

MINISYMPOSIUM ORGANIZER

- A. Manzoni, M.J. Zahr, “MS145: Reduced order modeling techniques in large scale and data-driven PDE problems,” SIAM Conference on Computational Science and Engineering, Atlanta, GA, February 27 – March 3, 2017

- Mar 2016 **Central Catholic High School Career Day** *Modesto, CA*
- Mar 2017 Presentation: Computational methods to solve next-generation science and engineering grand challenge problems; A workshop intended to demonstrate the real-world impact of CSE, convey my excitement and passion for the field, and hopefully motivate a diverse group of students to consider a CSE career

WORK EXPERIENCE

- Jun 2015 – **Research intern** *Livermore, CA*
 Sep 2015 Extreme-Scale Data Science and Analytics Department, Sandia National Laboratories
 Developed method for stochastic PDE-constrained optimization using adaptive reduced-order and sparse grids
- Jun 2012 – **Research intern** *Berkeley, CA*
 Sep 2012 Department of Mathematics, Lawrence Berkeley National Laboratory
- Jan 2011 – **Book reviewer** *Berkeley, CA*
 May 2011 Department of Mechanical Engineering, University of California, Berkeley
 Reviewed and edited two books written by Prof Tarek Zohdi prior to publication
 - T. I. Zohdi, *Electromagnetic Properties of Multiphase Dielectrics: A Primer on Modeling, Theory and Computation*, vol. 64. Springer Science & Business Media, 2012
 - T. I. Zohdi, *Dynamics of Charged Particulate Systems: Modeling, Theory and Computation*. Springer Science & Business Media, 2012
- Jun 2010 – **Research intern** *Stanford, CA*
 Sep 2010 Department of Aeronautics and Astronautics, Stanford University
- Jun 2009 – **Research intern** *Golden, CO*
 Aug 2009 Geologic Hazards Team, United States Geological Survey

RESEARCH EXPERIENCE

- 2015-pres **Acceleration of multiscale modeling via FEM² with reduced-order models**
 Introduced model reduction strategy to accelerate FEM² simulations for multiscale modeling. Reduction applied at microscale and adaptive algorithm introduced for adding fidelity to reduced-order model when training becomes insufficient.
Publications: [3]
Collaborators: Philip Avery, Charbel Farhat
- 2015-pres **CFD shape optimization using an embedded boundary method**
 Derived shape sensitivities of the FIVER embedded boundary method and used in a CFD shape optimization context to find the optimal shape of a full aircraft configuration in turbulent flow.
Result: Shape optimization capable without complication and robustness issues associated with mesh motion.
Publications: [12]
Collaborators: Dante De Santis, Charbel Farhat
- 2015-pres **Topology optimization using adaptive reduced-order models**
 Developed method to incorporate reduced-order models into a topology optimization framework for general, non-linear, 3D structures.; Reduced basis constructed for the state variable and optimization parameter, and an adaptive training strategy developed to ensure convergence to a near-optimal solution.
Result: Speedup of 10x achieved for 2D and 3D canonical compliance minimization problems, accounting for all offline and online cost.
Collaborators: Charbel Farhat
- 2012-pres **PDE-constrained optimization using reduced-order models**
 Developed method for simultaneously constructing a reduced-order model and using it to solve PDE-constrained optimization; novel, minimum-error reduced sensitivity formulation introduced; The simultaneous approach generates smaller, faster reduced-order models specialized to specific regions of the parameter space
Result: Errors well under 1% obtained with a factor of 4 fewer queries to the high-dimensional CFD model than standard PDE-constrained optimization techniques on a canonical problem from aerodynamic shape optimization.
Collaborators: Charbel Farhat

- 2012-2015 **Local bases for nonlinear model reduction**
 Model reduction approach defining multiple local bases in an offline phase, with most appropriate basis for the current position in state space chosen online an online phase; Promising approach for problems where the physics experiences multiple regimes (i.e. laminar/turbulent flow, small/large deformations)
Result: Local reduced-order bases capable of delivering similar accuracy as a global basis with many fewer degrees of freedom
Collaborators: Charbel Farhat, David Amsallem, Kyle Washabaugh
- 2010-pres **MORTestbed: A testbed for the comparison of model order reduction techniques on benchmark problems**
 Developed a testbed (MORTestbed) for the comparison of linear and nonlinear model reduction techniques. MORTestbed is a research tool used by model reduction researcher at Stanford University, Sandia Laboratory, and University of Texas, El Paso.; Performed a rigorous and impartial comparison of model reduction techniques common in industry and those being developed in the Farhat Research Group.
Collaborators: Charbel Farhat, David Amsallem, Kevin Carlberg
- 2015-pres **Stochastic PDE-constrained optimization using model reduction and sparse grids**
 Developed globally-convergent algorithm for stochastic PDE-constrained optimization using sparse grids and reduced-order models to approximately integrate objective function and gradient in stochastic space.; Inexactness in objective function and gradient controlled via probabilistic reduced-order model error indicators and dimension-adaptive sparse grids
Collaborators: Drew Kouri, Kevin Carlberg
- 2012-2013 **Performance tuning for discontinuous Galerkin methods**
 Investigated the effect of ODE solver, GMRES tolerance, Jacobian re-use, and Newton predictors on the simulation time of a high-order discontinuous Galerkin discretization of the Navier-Stokes equations solved using a Newton-Krylov method.; Introduced two A-stable, BDF-like schemes: BDF₂₃ (second-order) and BDF_{23_3} (third-order)
Result: Speedup factors of 6 were shown for optimal choices of these parameters over standard choices found in the literature.
Collaborators: Per-Olof Persson, Keith Miller
- 2015-pres **Time-dependent PDE-constrained optimization using high-order discontinuous Galerkin methods**
 Derived fully-discrete sensitivity and adjoint method for a globally high-order numerical discretization of conservation laws on deforming domains using an Arbitrary-Lagrangian-Eulerian form of the conservation law, a discontinuous Galerkin spatial discretization, diagonally-implicit Runge-Kutta temporal discretization, and solver-consistent discretization of output quantities.; Shooting method, built on fully-discrete sensitivity framework, used for determining time-periodic flows. Fully-discrete sensitivity and adjoint method derived for conservation law with periodic constraint.
Result: Framework used to determine optimal shape and flapping motion of an airfoil in viscous flow under nonlinear CFD-based constraints.
Collaborators: Per-Olof Persson, Jon Wilkening
- 2011-2011 **Electromagnetically-induced deformation of functionalized fabric**
 Developed code for simulation of fabric deformation by considering a discrete/lumped charged-mass yarn-segment network subject to external electromagnetic fields.
Collaborators: Tarek Zohdi
- 2010-2011 **Micro-columns as rate gyroscope motion sensors**
 Developed theory for the use of micro-columns as motion sensors.; Numerically integrated the Louisville Equation using a two-step Lax-Wendroff integration scheme to predict the effect that motion will have on the natural vibration of the micro-columns.
Collaborators: Sanjay Govindjee
- 2009-2009 **Seismic loading on high-rise structures**
 Processed data from the Pacific Earthquake Engineering Research Center (PEER) strong ground motion database using Bispec and MATLAB to create a new database.
Collaborators: Marios Panagiotou
- 2009-2011 **Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps**
 Implemented improvements to the seismic risk mapping tool on the USGS website.
Result: New version of the risk mapping tool enables users to: incorporate the effects of soil class on seismic risk, determine the seismic risk of a specific inventory of buildings as opposed to merely a generic region, and quantify risk as either the expected annual monetary loss or probability of a given level of damage.
Collaborators: Nicolas Luco, Hyeuk Ryu

TALKS

INVITED

- M. J. Zahr, “Accelerating PDE-constrained optimization problems using adaptive reduced-order models,” in *J. H. Wilkinson Fellowship Seminar (Host: Sven Leyffer)*, (Argonne, Illinois), Argonne National Laboratory, 1/15/2016
- M. J. Zahr, “Accelerating PDE-constrained optimization problems using adaptive reduced-order models,” in *John von Neumann Postdoctoral Fellowship Seminar (Host: Denis Ridzal)*, (Albuquerque, New Mexico), Sandia National Laboratories, 1/11/2016
- M. J. Zahr and P.-O. Persson, “High-order methods for optimization and control of conservation laws on deforming domains,” in *Dean Seminar at Sandia National Laboratories (Host: Kevin Carlberg)*, (Livermore, California), 12/14/2015
- M. J. Zahr, “Accelerating PDE-constrained optimization problems using adaptive reduced-order models,” in *Sidney Fernbach Postdoctoral Fellowship Seminar (Host: Jeffrey A. F. Hittinger)*, (Livermore, California), Lawrence Livermore National Laboratory, 12/9/2015
- M. J. Zahr and P.-O. Persson, “High-order methods for optimization and control of conservation laws on deforming domains,” in *Applied Mathematics Seminar at UC Berkeley (Host: Per-Olof Persson)*, (Berkeley, California), 9/30/2015
- M. J. Zahr and C. Farhat, “Accelerating PDE-constrained optimization using adaptive reduced-order models,” in *Seminar at Sandia National Laboratories (Host: Drew Kouri)*, (Albuquerque, New Mexico), 7/8/2015
- M. J. Zahr, “Accelerating PDE-constrained optimization using adaptive reduced-order models: application to topology optimization,” in *Robert J. Melosh Medal Competition*, (Durham, North Carolina), Duke University, 4/24/2015
- M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps,” in *Seminar at USGS headquarters (Host: Nicolas Luco)*, (Golden, Colorado), 6/8/2010
- M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps,” in *Undergraduate Research Seminar at UC Berkeley*, (Berkeley, California), 4/27/2010
- M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps,” in *Seminar at USGS headquarters (Host: Nicolas Luco)*, (Golden, Colorado), 8/13/2009

CONFERENCE

- M. J. Zahr, K. Carlberg, and D. P. Kouri, “Adaptive stochastic collocation for PDE-constrained optimization under uncertainty using sparse grids and model reduction,” in *SIAM Conference on Uncertainty Quantification*, (Lausanne, Switzerland), Ecole polytechnique federale de Lausanne, 4/5/2016 – 4/8/2016
- M. J. Zahr and P.-O. Persson, “High-order, time-dependent aerodynamic optimization using a discontinuous Galerkin discretization of the Navier-Stokes equations,” in *AIAA Science and Technology Forum and Exposition (SciTech 2016)*, (San Diego, California), 1/4/2016 – 1/8/2016
- K. Washabaugh, M. J. Zahr, and C. Farhat, “On the use of discrete nonlinear reduced-order models for the prediction of steady-state flows past parametrically deformed complex geometries,” in *AIAA Science and Technology Forum and Exposition (SciTech 2016)*, (San Diego, California), 1/4/2016 – 1/8/2016
- D. De Santis, M. J. Zahr, and C. Farhat, “Gradient-based aerodynamic shape optimization using the FIVER embedded boundary method,” in *AIAA Science and Technology Forum and Exposition (SciTech 2016)*, (San Diego, California), 1/4/2016 – 1/8/2016
- M. J. Zahr and P.-O. Persson, “Unsteady CFD optimization using high-order discontinuous Galerkin finite element methods,” in *13th U.S. National Congress on Computational Mechanics (USNCCM13)*, (San Diego, California), 7/26/2015 – 7/30/15
- M. J. Zahr and C. Farhat, “A nonlinear trust-region framework for PDE-constrained optimization using progressively constructed reduced-order models,” in *2015 SIAM Conference on Computational Science and Engineering (CSE15)*, (Salt Lake City, Utah), 3/14/2015 – 3/18/2015
- M. J. Zahr and C. Farhat, “PDE-constrained optimization using progressively constructed reduced-order models,” in *World Congress on Computational Mechanics XI (WCCM XI)*, (Barcelona, Spain), 7/20/2014 – 7/25/2014
- M. J. Zahr, K. Washabaugh, and C. Farhat, “Robust reduced-order models via fast, low-rank basis updates,” in *2014 SIAM Annual Meeting*, (Chicago, Illinois), 7/7/2014 – 7/11/2014
- M. J. Zahr and P.-O. Persson, “PDE-constrained optimization using progressively constructed reduced-order models,” in *International Conference on Spectral and High Order Methods (ICOSAHOM)*, (Salt Lake City, Utah), 6/23/2014 – 6/27/2014
- M. J. Zahr and C. Farhat, “Rapid nonlinear topology optimization using precomputed reduced-order models,” in *17th US National Congress on Theoretical and Applied Mechanics (USNCTAM)*, (East Lansing, Michigan), 6/15/2014 – 6/20/2014

- M. J. Zahr and C. Farhat, “PDE-constrained optimization using hyper-reduced models,” in *SIAM Conference on Optimization*, (San Diego, California), 5/19/2014 – 5/22/2014
- M. J. Zahr and C. Farhat, “Rapid nonlinear topology optimization using reduced-order models,” in *12th U.S. National Congress on Computational Mechanics (USNCCM12)*, (Raleigh, North Carolina), 7/22/2013 – 7/25/2013
- M. J. Zahr, D. Amsallem, and C. Farhat, “Construction of parametrically robust CFD-based reduced-order models for PDE-constrained optimization,” in *43rd AIAA Fluid Dynamics Conference and Exhibit*, (San Diego, California), 6/24/2013 – 6/27/2013
- M. J. Zahr and P.-O. Persson, “Performance tuning of Newton-GMRES methods for discontinuous Galerkin discretizations of the Navier-Stokes equations,” in *43rd AIAA Fluid Dynamics Conference and Exhibit*, (San Diego, California), 6/24/2013 – 6/27/2013
- D. Amsallem, M. J. Zahr, Y. Choi, and C. Farhat, “Design optimization using hyper-reduced order models,” in *10th World Congress on Structural and Multidisciplinary Optimization (WCSMO10)*, (Orlando, Florida), 3/19/2013 – 3/24/2013
- M. J. Zahr and C. Farhat, “Construction of parametrically robust reduced-order models for PDE-constrained optimization,” in *10th World Congress on Structural and Multidisciplinary Optimization (WCSMO10)*, (Orlando, Florida), 3/19/2013 – 3/24/2013
- D. Amsallem, K. Washabaugh, M. J. Zahr, and C. Farhat, “Efficient nonlinear model reduction approach using local reduced bases and hyper-reduction,” in *2013 SIAM Conference on Computational Science and Engineering (CSE13)*, (Boston, Massachusetts), 2/25/2013 – 3/1/2013
- M. J. Zahr and C. Farhat, “Efficient, parametrically robust nonlinear model reduction using local reduced-order bases,” in *2013 SIAM Conference on Computational Science and Engineering (CSE13)*, (Boston, Massachusetts), 2/25/2013 – 3/1/2013
- D. Amsallem, M. J. Zahr, and C. Farhat, “Nonlinear model order reduction with local reduced-order bases for hyper-reduction,” in *Proceedings of the 2012 European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS)*, (Vienna, Austria), 9/10/2012 – 9/14/2012
- D. Amsallem, C. Farhat, and M. J. Zahr, “Real-time CFD-based fluid-structure predictions using a database of parameterized reduced-order models,” in *10th World Congress on Computational Mechanics (WCCM X)*, (Sao Paulo, Brazil), 7/8/2012 – 7/13/2012
- D. Amsallem, M. J. Zahr, and C. Farhat, “On the robustness of residual minimization for constructing POD-based reduced-order CFD models,” in *43rd AIAA Fluid Dynamics Conference and Exhibit*, (San Diego, California), 6/27/2011 – 6/30/2011
- K. Carlberg, J. Cortial, D. Amsallem, M. J. Zahr, and C. Farhat, “The GNAT nonlinear model reduction method and its application to fluid dynamics problems,” in *AIAA Paper 2011-3112, 6th AIAA Theoretical Fluid Mechanics Conference*, (Honolulu, Hawaii), 6/27/2011 – 6/30/2011

WORKSHOP

- M. J. Zahr and C. Farhat, “A nonlinear trust-region framework for PDE-constrained optimization using adaptive model reduction,” in *West Coast ROM Workshop*, (Livermore, California), Sandia National Laboratories, 11/19/2015
- M. J. Zahr and C. Farhat, “Accelerating PDE-constrained optimization using progressively constructed reduced-order models,” in *Bay Area ROM Workshop*, (Livermore, California), Sandia National Laboratories, 8/8/2014
- M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps,” in *PEER Internship Summer Meeting*, (webcast), 8/18/2009

POSTERS

- M. J. Zahr and P.-O. Persson, “Unsteady PDE-constrained optimization using high-order DG-FEM,” in *13th U.S. National Congress on Computational Mechanics (USNCCM13)*, (San Diego, California), 7/26/2015 – 7/30/15
- M. J. Zahr and C. Farhat, “Progressive construction of a parametric reduced-order model for PDE-constrained optimization,” in *2014 DOE CSGF Annual Program Review*, (Washington D.C.), 7/14/2014 – 7/17/2014
- M. J. Zahr and C. Farhat, “Rapid topology optimization using reduced-order models,” in *2013 DOE CSGF Annual Program Review*, (Washington D.C.), 7/25/2013 – 7/27/2013
- M. J. Zahr and C. Farhat, “Rapid structural shape optimization using progressively constructed reduced-order models,” in *12th U.S. National Congress on Computational Mechanics (USNCCM12)*, (Raleigh, North Carolina), 7/22/2013 – 7/25/2013
- M. J. Zahr and C. Farhat, “Design of fluid mechanical systems using reduced-order models,” in *2012 DOE CSGF Annual Program Review*, (Washington D.C.), 7/26/2012 – 7/28/2012
- M. J. Zahr, C. Farhat, K. Carlberg, and D. Amsallem, “Comparison of model reduction techniques on linear and nonlinear electrical, mechanical, and biological systems,” in *UC Berkeley Undergraduate Research Poster Session*, (Berkeley, California), 4/19/2011

- M. J. Zahr, C. Farhat, K. Carlberg, and D. Amsallem, “Comparison of model reduction techniques on linear and nonlinear electrical, mechanical, and biological systems,” in *2011 SIAM Conference on Computational Science and Engineering (CSE11)*, (Reno, Nevada), 3/1/2011
- M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps,” in *2009 PEER Annual Meeting*, (San Francisco, California), 10/15/2009 – 10/16/2009
- M. J. Zahr, N. Luco, and H. Ryu, “Mitigation of seismic risk pertaining to non-ductile concrete buildings using seismic risk maps,” in *2009 Young Researcher’s Symposium*, (Buffalo, New York), 8/20/2009 – 8/22/2009

SHORT COURSES & WORKSHOPS ATTENDED

Computational Conformal Geometry for Surface and Volume Meshing, Short Course, International Meshing Roundtable (IMR), Washington D.C., USA, September 25 – 29, 2016

Computational Fluid-Structure Interaction, Short Course, World Congress on Computational Mechanics XI (WCCM XI), Barcelona, Spain, July 19 – 25, 2014

Discovering Big Data, High Performance Computing Workshop, San Diego Supercomputing Center (SDSC) Summer Institute, San Diego, CA, August 5 – 9, 2013

Using Algorithmic Differentiation to Compute Derivatives for Sensitivity Analysis, Uncertainty Quantification, and Optimization, Short Course, 12th U.S. National Congress on Computational Mechanics (USNCCM12), Raleigh, NC, July 22 – 25, 2015

COURSE WORK

Mathematics

real and complex analysis · linear and modern algebra · differential geometry · convex optimization · numerical linear algebra · numerical optimization · theoretical and numerical PDEs · stochastic methods · discrete mathematics and algorithms

Engineering

rigid body dynamics · continuum mechanics · finite element analysis · fluid mechanics · computational fluid dynamics · meshing · model reduction · computational plasticity · computational fracture mechanics · computational fluid-structure interaction

Computer science

machine learning · big data · parallel computing (MPI, openMP, CUDA) · algorithmic differentiation

TECHNICAL SKILLS

C++, MATLAB, Python programming · Unix, LaTeX · COMSOL, Finite Element Analysis Program (FEAP), SAP 2000 · MPI, OpenMP parallelism · AutoCAD

OTHER INTERESTS

boxing · hiking · weightlifting · downhill skiing · running

Last updated: January 23, 2017 • Typeset in \LaTeX
http://math.lbl.gov/~mjzahr/extras/ZahrMatthew_CV.pdf